

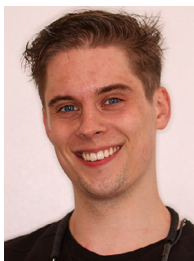


Esmail Eruptor: A novel approach to align partially erupted teeth

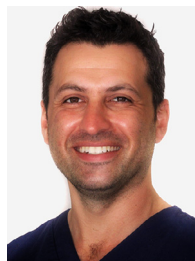
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Orthodontic treatment often encounters challenges posed by partially erupted teeth, necessitating innovative approaches to expedite alignment. This article introduces the Esmail Eruptor, a novel device designed to align partially erupted teeth within 4-6 weeks. The Esmail Eruptor consists of a stainless-steel attachment with a mesh base and an offset wire slot, facilitating its bonding to teeth with minimal enamel exposure, yet allowing greater activation of the nickel-titanium wires. Clinical patients demonstrate successful outcomes with the Esmail Eruptor, highlighting its efficacy in expediting treatment progression. Moreover, considerations for impacted teeth, biomechanics, and potential side effects are also discussed. The device offers a promising solution to the challenges posed by partially erupted teeth, ensuring timely and efficient orthodontic treatment. (Am J Orthod Dentofacial Orthop Clin Companion 2024;4:86-92)



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Orthodontic treatment often commences between 11 and 12 years old when the late mixed or early permanent dentition is most likely established¹; however, it is not uncommon to observe deviations from the accepted norms of tooth eruption, and occasionally, treatment may need to be started sooner if the stated chronological age does not align with the dental developmental age.² Furthermore, delayed or late eruption can occur because of a variety of systemic, genetic, and local factors³ and often necessitates interceptive treatment to aid the eruption of, for example, impacted teeth, such as maxillary canines and second premolars.

This article provides a brief overview of when partially erupted teeth are encountered and discusses current

techniques and a novel approach to rapidly align a partially erupted tooth in 4-6 weeks.

BACKGROUND

During fixed appliance treatment in the early permanent dentition, there are 2 principal scenarios in which we encounter partially erupted teeth in the early permanent dentition:

1. Impacted maxillary canines: Excluding third molars, maxillary canines are the most commonly impacted teeth, with an incidence of 2%.⁴ By the time the eruption of the maxillary canine begins, it is often the last tooth to erupt in the maxillary anterior region,⁵ and space may not be available. Indeed, 83% of buccally impacted canines occur because of an arch-length deficiency⁶ and instead erupt severely displaced. Several studies have shown that space creation can aid the eruption of impacted canines.^{7,8} It must be noted that two-thirds of impacted canines are located palatally^{9,10} and may require either surgical exposure or removal if the patient is at detrimental risk of the sequelae of complications that may occur.¹¹ Surgical exposure is often the most desirable approach¹² and then allowing the tooth to erupt naturally or applying traction with a bondable attachment.¹³
2. Mandibular second premolars: Similarly, primary mandibular second molars are the last to exfoliate in the arch and the second most common primary tooth impaction.¹⁴ These circumstances provide an opportunity for late exfoliation and eruption, impaction, or displacement of the successor. The incidence of

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mandibular second premolar impaction is thought to be approximately 0.5%, comprising approximately 25% of all dental impactions.^{15,16} Extraction of the primary second molar and monitoring the eruption of the successor may provide a noninvasive and cost-effective approach.¹⁷ Orthodontically creating space to allow eruption may offer a better and long-term prognosis with no adverse pulpal or periodontal risk to the tooth or the supporting structure.^{18,19}

The challenge when dealing with partially erupted teeth in these clinical scenarios is that treatment cannot progress until all the teeth have aligned and the working archwire can be fitted. Therefore, partially erupted teeth can sometimes delay treatment progression until they are aligned.

CURRENT METHODS

Orthodontic preadjusted edgewise brackets are traditionally placed on the facial axis (FA) of the anatomic crown; however, when dealing with a recently emerged tooth, the FA point is submerged below the gingival margin. The current options for managing partially erupted teeth are outlined below:

1. Passive space maintainer: A space maintainer such as plastic archwire tubing or a passive closed coil can be integrated into the fixed appliance, and the patient is reviewed regularly until the gingiva can be retracted to visualize the FA point.⁸
2. Gingivectomy: The use of a scalpel can create a window into the gingiva to allow adequate visualization of the FA point. Often, the bracket cannot be bonded in the same visit because of improper isolation, leading to inadequate bonding. Recent innovations with lasers can enhance precision and provide better hemostatic ability and faster wound healing, with less scarring and pain.²⁰
3. Elastic traction: An attachment is bonded to the available enamel, and intermaxillary elastics can be used to provide orthodontic traction to the partially erupted tooth. Elastomeric chains running from the attachment to an offset bend in the archwire can also be used to apply traction.²¹
4. Sequential repositioning: Once enough bonding surface becomes available for an eyelet attachment or a preadjusted edgewise bracket, a nickel-titanium (NiTi) wire can integrate a partially erupted tooth into the fixed appliance. The amount of forced eruption is dependent on the activation of the archwire, and several visits are needed to sequentially resite the eyelet or bracket until the FA point can be bonded to it.²²
5. Overlaying the archwire: A stainless steel base archwire is ligated into the brackets of the adjacent teeth, and a NiTi piggyback archwire is then ligated to the partially erupted tooth. This will minimize any

intrusive forces to the adjacent teeth and reduce any unwanted tooth movements.²³

6. Sequential wire bending: Extrusion bends can be incorporated into the appliances; however, these bends would likely need to be reactivated on a number of occasions until the FA point of the canine is visible.²²
7. Using a cantilever: An adjunctive archwire made from either beta-titanium or stainless steel is fabricated and fitted into the auxiliary tube of a double-tube bonded molar. The wire is then deflected and ligated to the partially erupted tooth to aid extrusion.²⁴

In our experience, the above methods can take multiple visits in a protracted timeframe to complete.

ESMAIL ERUPTOR

The Esmail Eruptor (London, United Kingdom. <https://www.esmaileruptor.co.uk>) consists of a stainless steel attachment with a mesh base and an offset wire slot that is perpendicular to the bonding surface of the tooth (Fig 1). This can be bonded to the tooth as soon as there is a minimum of 2 mm of enamel available to allow sufficient isolation using standard bonding protocols.

The tubing allows a round NiTi wire to be placed directly above the FA point of the tooth, ensuring adequate deflection of the wire and sufficient orthodontic force to be applied (Fig 2). This novel method can erupt the tooth by 3-5 mm within 4-6 weeks until a conventional bracket can be bonded to the FA point, and the partially erupted tooth can be included and ligated into the fixed appliance after a single visit.



Fig 1. Single Tube Esmail Eruptor.

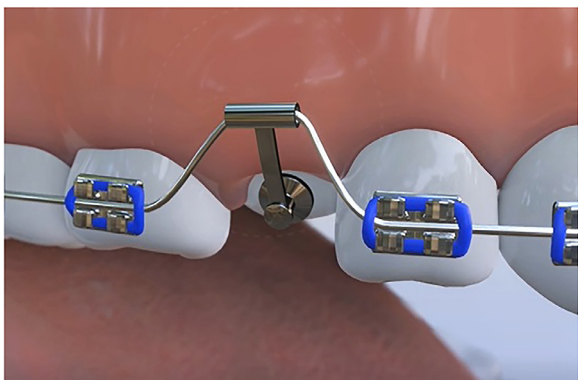


Fig 2. Animation demonstrating Esmail Eruptor In-Situ.

The Esmail Eruptor allows greater deflection of the NiTi wires and thus uses the forces of the NiTi wire as per their force-deflection curve. These studies showed that the relationship between the deflection of the NiTi wire and the force generated is not linear, and thus, because of the superelastic properties of the NiTi wire, a greater deflection does not always translate into a greater force being applied to the tooth.²⁵

According to Newton’s third law of motion, every action has an equal and opposite reaction. In the case of the Esmail Eruptor, the extrusive forces applied to the tooth are counterbalanced by the intrusive forces of the adjacent teeth. According to Ng et al,²⁶ true intrusion rarely occurs, and extrusion is more likely to transpire. There will be a small intrusion of the adjacent teeth as a side effect of the extrusive forces applied to the partially erupted tooth. However, the main purpose of the Esmail Eruptor is to align the tooth enough so that a conventional bracket can be bonded to the FA point, and the leveling can occur with stiffer archwires later on in treatment.

Moreover, depending on the crown height, wire deflection, and anchorage demand, the sequential eruption can still be used by using the Esmail Eruptor with double tubing. However, a blinded, randomized control trial would be needed to compare the Esmail Eruptor to the current treatment methods.

IMPACTED TEETH

The initial design of the Esmail Eruptor was aimed at efficiently erupting partially erupted teeth. However,

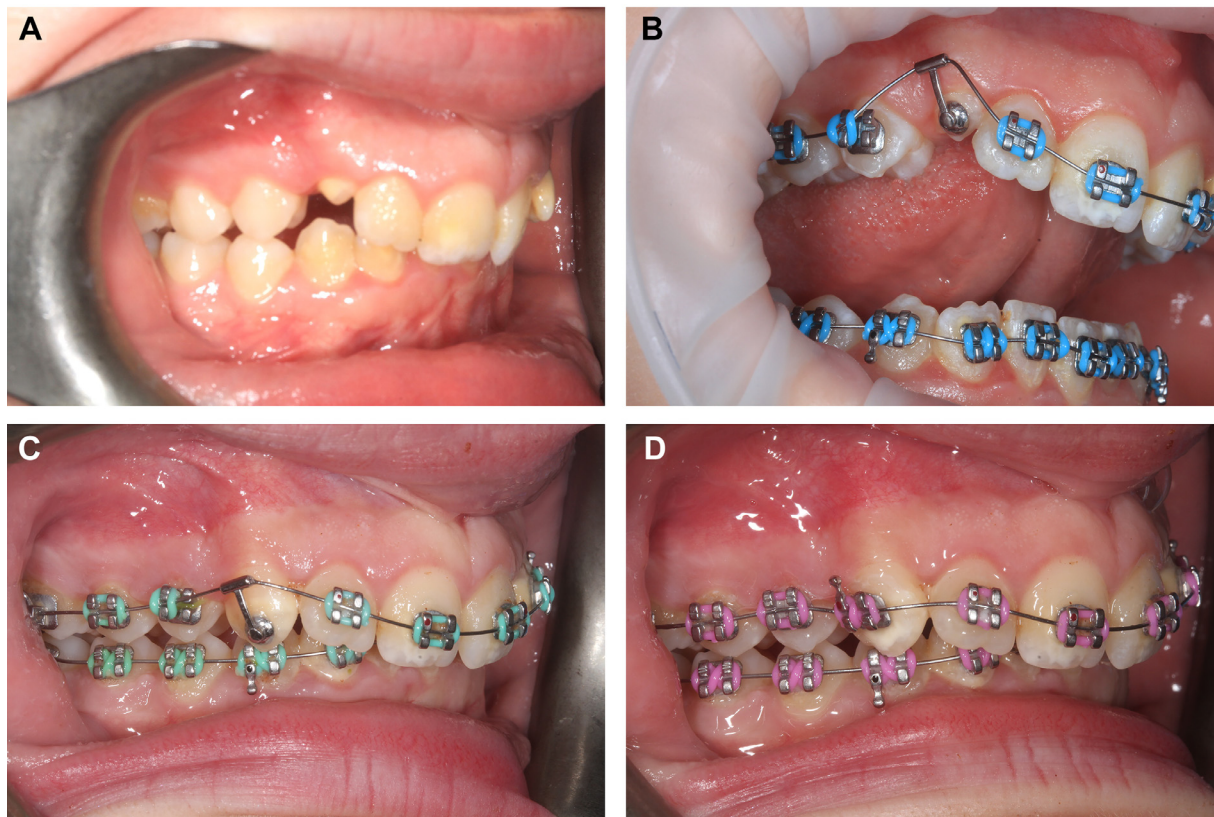


Fig 3. Patient AB: **A**, Pretreatment; **B**, Esmail Eruptor bonded to the UR3; **C**, Result after 6 weeks; **D**, Bracket bonded on the FA point of the UR3.

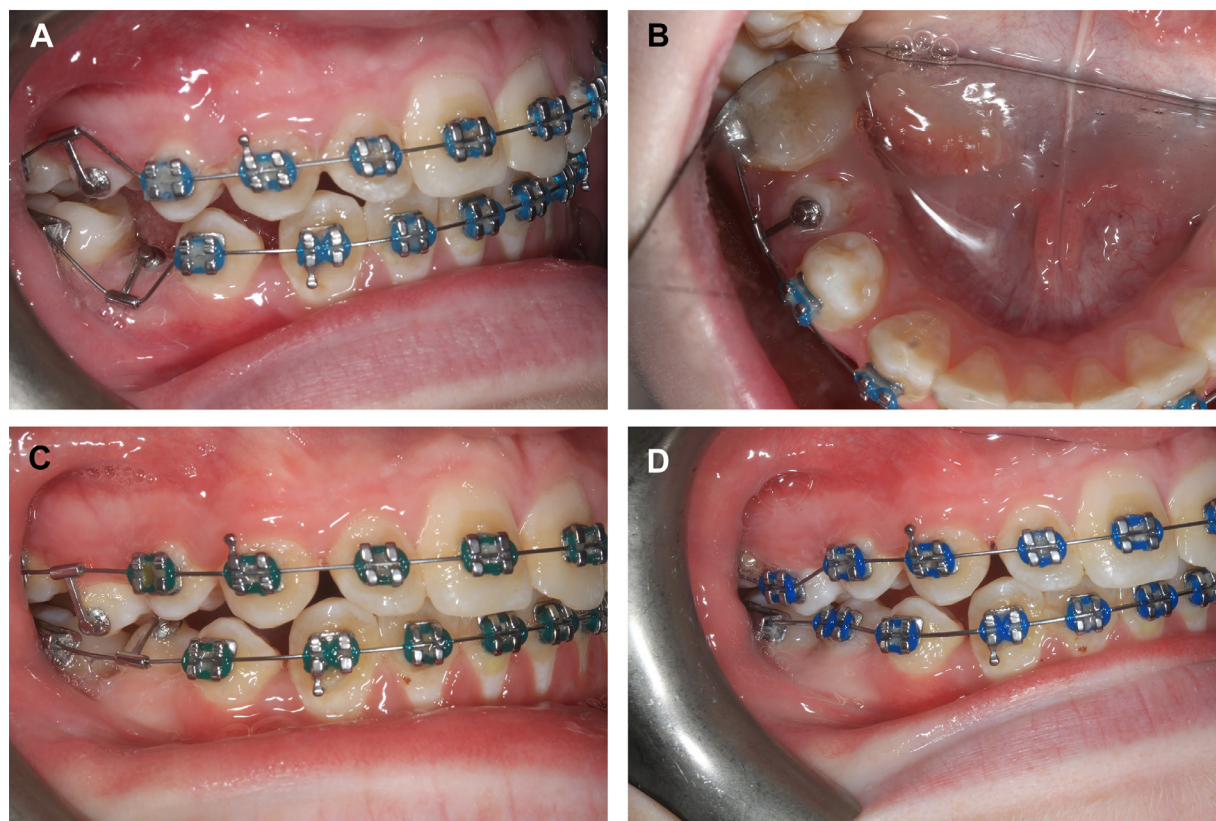


Fig 4. Patient EF: **A**, Esmail Eruptor bonded to the UR5 and LR5; **B**, Occlusal view showing Esmail Eruptor; **C**, Result after 6 weeks; **D**, Bracket bonded on the FA point of the UR5 and LR5.

consideration can be taken for the use of impacted canines. For buccally placed canines, in which an apically repositioned flap is indicated, an Esmail Eruptor can be bonded onto the tip of the canine. This will allow less soft-tissue removal as part of the surgery, with the added benefit of only needing to bond one attachment to erupt the tooth fully. However, depending on the amount of displacement of the canine sequential eruption, using the double eruptor may be a better option to keep the forces light.

For impacted teeth requiring a conventional gold chain, the gold chain is used to bring the impacted tooth into the arch. Often, with eruptions with gold chains, the tooth erupts and rotates, and only part of the crown is visible; thus, the FA point is not visible. At this stage, the Esmail Eruptor can be used to erupt the tooth efficiently, further allowing a conventional bracket to be bonded on the FA point.

CASE REPORTS

Patient AB presented with a Class II, Division 2 incisor relationship with a partially erupted maxillary right canine (UR3); to progress the treatment efficiently, we needed to align the UR3, which was partially erupted. An Esmail

Eruptor was bonded to the UR3, and a 0.014-in NiTi wire was ligated and placed through the tube. Six weeks later, the UR3 had erupted fully, and a conventional bracket was bonded to the FA point of the UR3 (Fig 3).

Patient EF was nearing the end of orthodontic treatment, and the deciduous second molars were late to exfoliate. Once exfoliated, the successive second premolar was starting to erupt. An Esmail Eruptor was bonded to the mandibular and maxillary right second premolars, and a 0.014-in NiTi wire was ligated. Six weeks later, both the mandibular and maxillary right second premolars had fully erupted, and a conventional bracket was bonded to the FA point. Now, treatment can progress to completion (Fig 4).

Patient LD attended with an unerupted maxillary left canine (UL3); the plan was to create space to allow the UL3 to erupt. Once a small portion of the tip of the UL3 has erupted, an Esmail Eruptor was bonded to the tooth. A 0.014-in NiTi wire was ligated. Six weeks later, the tooth had fully erupted, and a conventional bracket was bonded to the FA point (Fig 5).

DISCUSSION

There are various orthodontic methods available for achieving orthodontic extrusion of partially erupted teeth



Fig 5. Patient LD: **A**, Pretreatment photos; **B**, Space was created to allow the UL3 to erupt; **C**, Esmail Eruptor bonded to the UL3; **D**, Result after 6 weeks; **E**, Bracket bonded on the FA point of the UL3.

with fixed appliances. However, certain methods only allow a minimal amount of activation at a time. Anecdotally, this has been our experience in the past, which led to the development of this new device.

This novel approach to rapidly extrude partially erupted teeth is designed for early or late fixed appliance treatment, in which there is at least 2 mm of bondable surface available that can be reliably isolated. After a single visit (6-8 weeks), a tooth can be

fully erupted to be ligated into the orthodontic appliance.

The biomechanics of this treatment are straightforward: the tube portion of the Esmail Eruptor, which receives the wire, is offset from the bondable pad. This allows the NiTi wire to be placed closer to the FA point of the unerupted tooth, even when this portion of the tooth is still lying under the gingivae. Therefore, this allows a greater deflection of the NiTi wire, which allows greater activation of the

appliance. We know from previous NiTi alignment studies to properly use the superelastic properties of NiTi wires, it is necessary to deform them beyond a certain bending angle by as much as 50°-70° to reach their superelastic plateau.^{27,28} The offset between the bondable base and the wire receiving portion allows us to achieve this with efficiency.

Care must be taken when considering extruding teeth; the main considerations should be ankylosed teeth and vertical anchorage considerations. In patients with tenuous or reduced overbite, the use of the Esmail Eruptor should be carefully planned. Just as in the current treatment methods of aligning partially erupted teeth, the use of an intermaxillary elastic or the use of a stronger base archwire are 2 options to manage the vertical anchorage; both of which are compatible with the Esmail Eruptor.

One concern about this device is the worry that some palatal or lingual movement may occur as a side effect; however, the lever arm of the appliance is pliable and can be bent and adjusted to negate this side effect. In our experience using this device, there is very limited palatal movement that does occur; one of the authors (Z.E.) has completed >30 patients using this appliance. However, the primary purpose of the Esmail Eruptor is to erupt the tooth efficiently to allow the placement of a conventional bracket in the FA point as quickly as possible. Therefore, any palatal movement that does occur will be corrected when a conventional bracket is placed and fully ligated when incorporated into the rest of the fixed appliance. There is no doubt there is an element of round-tripping associated with this. However, the author believes that this can be heavily offset by the speed at a conventional bracket that can be placed on the FA point so that the treatment can progress efficiently despite any round-tripping that may occur.

Buccal or lingual tipping of adjacent teeth can occur depending on the initial position of the adjacent teeth. This can be corrected as the treatment progresses into stiffer rectangular archwires as the torque will be expressed.

Other side effects include (1) archwire notching, which can occur when the NiTi is excessively deflected into the Esmail Eruptor tube and (2) excessive extrusion of the tooth being erupted.

In addition to the mentioned side effects, the disadvantages of using this appliance include (1) gingival irritation or soft-tissue trauma, (2) potential for intrusion of adjacent teeth, and (3) overcorrection of the extrusion.

CONCLUSIONS

Partially erupted teeth can present a challenge in fixed appliance treatment. By using this novel approach, a partially erupted tooth can be fully ligated into the fixed

appliance within a single visit, ensuring timely completion of the treatment without compromising treatment objectives. Further, blinded randomized controlled trials are needed to compare the speed of alignment of partially erupted teeth, comparing conventional methods of alignment against the Esmail Eruptor.

AUTHOR CREDIT STATEMENT

Mischa Railton contributed to original draft preparation and manuscript review and editing, and Zaid Esmail contributed to conceptualization, resources, and manuscript review and editing.

CONFLICT OF INTEREST

Zaid Esmail invented, designed, and is the patent holder of the Esmail Eruptor and thus has a financial interest in the product.

STATEMENT OF INFORMED CONSENT

Informed consent was obtained by patients and/or legal guardians for the use of the images.

Supplementary materials

Supplementary material associated with this article can be found in the online version at [doi:10.1016/j.xaor.2024.02.004](https://doi.org/10.1016/j.xaor.2024.02.004). (See Video, available at www.ajodo.org).

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